

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY
SBIR 2004.2 Submission of Proposals

DARPA's charter is to help maintain U.S. technological superiority over, and to prevent technological surprise by, its potential adversaries. Thus, the DARPA goal is to pursue as many highly imaginative and innovative research ideas and concepts with potential military and dual-use applicability as the budget and other factors will allow.

DARPA has identified technical topics to which small businesses may respond in the second fiscal year (FY) 2004 solicitation (FY 2004.2). Please note that these topics are UNCLASSIFIED and only UNCLASSIFIED proposals will be entertained. Although the topics are unclassified, the subject matter may be considered to be a "critical technology". If you plan to employ NON-U.S. Citizens in the performance of a DARPA SBIR contract, please identify these individuals in your proposal as specified in Section 3.5.b(7) of the program solicitation. A list of the topics currently eligible for proposal submission is included in this section followed by full topic descriptions. These are the only topics for which proposals will be accepted at this time. The topics originated from DARPA technical program managers and are directly linked to their core research and development programs.

DARPA **NOW** requires electronic submission of Cover Sheets, Technical and Cost proposals, and Company Commercialization Report. A hardcopy is no longer required. Only proposals submitted through the on-line submission site at www.dodsbir.net/submission will be accepted or considered for award. Proposals must be prepared and submitted in accordance with the DoD Program Solicitation at www.dodsbir.net/solicitation and following the instructions below.

PLEASE DO NOT ENCRYPT OR PASSWORD PROTECT YOUR TECHNICAL PROPOSAL

HELPFUL HINTS:

1. Consider the file size of the technical proposal to allow sufficient time for uploading.
2. Perform a virus check.
3. Signature is no longer required at the time of submission.
4. Submit a new/updated Company Commercialization Report.
5. Please call the Toll Free SBIR Help Desk if you have submission problems: 866-724-7457
6. DARPA will not accept proposal submissions by electronic facsimile (fax) or email.

DARPA Phase I awards will be Firm Fixed Price contracts.

Phase I proposals shall not exceed \$99,000, and should be a **6-month effort**. Phase I contracts can ONLY be extended if the DARPA Technical Point of Contact decides to "gap" fund the effort to keep a company working while a Phase II proposal is being generated.

DARPA Phase II proposals must be invited by the respective Phase I DARPA Program Manager (with the exception of Fast Track Phase II proposals – see Section 4.5 of this solicitation). Phase 2 invitations will be based on the technical results reflected in the Phase I draft and/or final report as evaluated by the DARPA Program Manager utilizing the criteria in Section 4.3. DARPA Phase II proposals must be structured as follows: the first 10-12 months (base effort) should be approximately \$375,000; the second 10-12 months of incremental funding should also be approximately \$375,000. The entire Phase II effort should generally not exceed \$750,000.

It is expected that a majority of the Phase II contracts will be Cost Plus Fixed Fee. However, DARPA may choose to award a Firm Fixed Price Contract or an Other Transaction, on a case-by-case basis.

Prior to receiving a contract award, the small business **MUST** be registered in the Centralized Contractor Registration (CCR) Program. You may obtain registration information by calling 1-888-352-9333 and pressing 3 or Internet at www.ccr.gov.

The responsibility for implementing DARPA's SBIR Program rests in the Contracts Management Office. The DARPA SBIR Program Manager is Ms. Connie Jacobs.

SBIR proposals will be processed by the DARPA Contracts Management Office and distributed to the appropriate technical office within DARPA for evaluation and action.

DARPA selects proposals for funding based on technical merit and the evaluation criteria contained in this solicitation document. DARPA gives evaluation criterion a., “The soundness and technical merit of the proposed approach and its incremental progress toward topic or subtopic solution” (refer to section 4.2 Evaluation Criteria - Phase I), twice the weight of the other two evaluation criteria. **GOVERNMENT TRANSITION OF THE PROPOSED EFFORT IS VERY, VERY IMPORTANT. THE SMALL BUSINESS SHOULD INCLUDE THEIR TRANSITION VISION IN THEIR COMMERCIALIZATION STRATEGY. THE SMALL BUSINESS MUST UNDERSTAND THE END USE OF THEIR EFFORT AND THE END USER, i.e., ARMY, NAVY, AF, SOCOM, ETC.**

As funding is limited, DARPA reserves the right to select and fund only those proposals considered to be superior in overall technical quality and highly relevant to the DARPA mission. As a result, DARPA may fund more than one proposal in a specific topic area if the technical quality of the proposal(s) is deemed superior, or it may not fund any proposals in a topic area. Each proposal submitted to DARPA must have a topic number and must be responsive to only one topic.

Cost proposals will be considered to be binding for 180 days from closing date of solicitation.

Successful offerors will be expected to begin work no later than 30 days after contract award.

For planning purposes, the contract award process is normally completed within 45 to 60 days from issuance of the selection notification letter to Phase I offerors.

The DoD SBIR Program has implemented a Fast Track process for SBIR projects that attract matching cash from an outside investor for the Phase II SBIR effort, as well as for the interim effort between Phases I and II. Refer to Section 4.5 for Fast Track instructions. DARPA encourages Fast Track Applications ANYTIME during the 6th month of the Phase I effort. The Fast Track Phase II proposal must be submitted no later than the last business day in the 7th month of the effort. **Technical dialogues with DARPA Program Managers are encouraged to ensure research continuity.** If a Phase II contract is awarded under the Fast Track program, the amount of the interim funding will be deducted from the Phase II award amount. It is expected that interim funding will generally not exceed \$40,000.

To encourage the transition of SBIR research into DoD Systems, DARPA has implemented a Phase II Enhancement policy. Under this policy DARPA will provide a Phase II company with additional Phase II SBIR funding, not to exceed \$200K, if a DARPA Program Manager can match the additional SBIR funds with DARPA core-mission funds or the company can match the money with funds from private investors; or at the discretion of the DARPA Program Manager. DARPA will generally provide the additional Phase II funds by modifying the Phase II contract.

DARPA FY2004.2 Phase I SBIR
Checklist

Page Numbering

Number all pages of your proposal consecutively _____

Total for each proposal is 25 pages inclusive of cost proposal and resumes.

Beyond the 25 page limit do not forward appendices, attachments and/or additional references.

Company Commercialization Report **IS NOT** included in the page count

Proposal Format

b. Cover Sheet, Technical and Cost proposals, and Company Commercialization Report **MUST** be submitted electronically _____

c. Identification and Significance of Problem or Opportunity _____

d. Phase I Technical Objectives _____

e. Phase I Work Plan _____

f. Related Work _____

g. Relationship with Future Research and/or Development _____

h. Commercialization Strategy _____

i. Key Personnel, Resumes _____

j. Facilities/Equipment _____

k. Consultants _____

l. Prior, Current, or Pending Support _____

m. Cost Proposal _____

n. Company Commercialization _____

SUBJECT/WORD INDEX TO THE DARPA FY2004.2 TOPICS

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DARPA 04.2 Topic List

SB042-033	Optical Time Delay Modules for RF Systems and Telecommunications
SB042-034	Large Area Portable Radar Antenna Arrays
SB042-035	Physical Integrity Monitoring

DARPA 04.2 Topic Descriptions

SB042-033

TITLE: Optical Time Delay Modules for RF Systems and Telecommunications

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace, Weapons

OBJECTIVE: Develop high-resolution (>8 bits) optical time delay modules that exhibit low optical insertion loss (< 3 dB) and fast reconfiguration times (< 10 micro-seconds).

DESCRIPTION: Microwave photonics for broadband radio frequency (RF) signal transmission and signal processing have attracted considerable attention over the past 20 years. Recent broadband analog photonic link performance improvements have renewed the interest and activity in developing this technology. Increased bandwidths and reduced fiber optic link insertion loss/noise figure accompanied by increased dynamic range have created real insertion opportunities of advanced fiber optic signal distribution manifolds and RF photonic signal processors into antenna-based communications, radar, navigation, and electronic warfare systems. A key photonic integrated circuit module that enables many of the tunable microwave filtering and true-time-delay (TTD) signal processing applications is a low insertion loss, variable optical delay line with fast reconfiguration time. The development of an affordable high-performance time delay device enables many tapped delay line signal processing architectures of military interest. On the optical telecommunications side, all-optical networks and optical routers provide a clear path to allowing sizeable information capacity expansion in a size/weight/power efficient manner. A significant challenge to achieving an all-optical router is dynamic optical buffering. Switched optical delay line architectures have been proposed as a possible solution to address this problem. Fortunately, many of the requirements and desired specifications for variable optical time delay modules for use in both the optical telecommunications and RF systems application areas are quite similar. In view of these overlapping requirements, this topic addresses the need for developing fast, low loss, scalable, switched optical delay line modules that can meet the challenging loss and bit resolution requirements. Scalability is required in terms of time resolution/precision and delay range to satisfy various military and commercial applications. Innovative photonic device/module/system research and development is solicited that addresses this critical need.

Aggressive military/commercial RF and optical networking system performance requirements continue to drive and push the limits of high-speed electronic and optical device/module technology. Optical switching technology and highly dispersive optical waveguide technologies are no exception. These two fast moving technology areas form the basis as prime candidates for achieving high performance variable optical time delay modules. Many optical switch fabrics, including Micro Electro-Mechanical Systems (MEMS), thermal, electro-optic, and magneto-optic switches have been demonstrated and are potentially applicable to meeting the requirements for producing robust time delay modules. Speed, loss, polarization, temperature and lifetime performance as well as size, weight and power will be key differentiators in selecting potential switching technologies. The ability to efficiently couple single-mode fiber is important for providing longer delays. The wavelength of choice for the time delay module is in the 1550 nm region to be compatible with currently available Wavelength Division Multiplexing (WDM) technology.

Fiber Bragg grating based and other optical wavelength dependent time delay modules will also be considered in this topic. Many time delay devices have been demonstrated that use a tunable wavelength laser in conjunction with a highly dispersive optical waveguide. In addition to the set of technology differentiators discussed above, tunable laser availability, system latency and wavelength dependent system performance impacts will be important factors in evaluating these wavelength dependent approaches.

Minimizing the loss within optical signal processors is absolutely essential in meeting military and commercial system performance requirements and loss budgets. This cannot be emphasized enough and technologies best suited to address the loss issue will be highlighted. The utility of an optical processor is severely compromised as its optical insertion loss increases. A major thrust of this topic will be to demonstrate extremely low insertion loss modules and technologies that can be readily integrated into fiber based systems. Preferred time delay module approaches will show a direct path to achieving or surpassing the <10 micro-seconds reconfiguration (switching and settling) times.

PHASE I: Propose a feasibility study to investigate, model, and perform critical experiments to identify possible electro-optic component, device and integration approaches to achieving variable optical time delay modules with <10 micro-seconds switching time, >8 bit resolution and <3 dB total optical insertion loss. Multi-channel and tapped delay line architectures for adaptive signal processing applications will also be studied.

PHASE II: Develop 4-bit (interim) and 8-bit (final) prototype variable time delay modules and demonstrate optical performance. Perform laboratory testing of modules and adaptive signal processors in experimental setups that demonstrates their utility in both military RF systems and commercial optical telecommunication systems.

PHASE III Dual Use Applications: PHASE III Dual Use Applications: The programmable time delay module and related TTD signal processors will be transitioned to commercial production for dual use applications. The primary military use will be in radar, communication and electronic warfare antenna signal processing systems. Wideband TTD applications including ECM,

radar signal simulators, tunable microwave filtering and phased-array beam steering are key military insertions for this technology. Targeting these applications, the optoelectronic modules will be deployed on space, airborne, ground and maritime military command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) platforms. Modest market sizes are projected for these military applications in comparison to size anticipated for the optical telecommunications industry. The optoelectronic time delay modules will provide an affordable optical buffering solution within all-optical routers. The optical telecommunications industry has been in search of such a device. A successful development in terms of unit cost and performance, will lead to a large market in optical networking systems for both wide area networks (WANs) and metro area networks (MANs), a multi-billion dollar commercial market. Cost is critical in commercial networking applications and ultimately determines volumes and market size. Low cost manufacturing will be a focus throughout this development to ensure the commercial viability of this technology.

REFERENCES:

1. "Use of RF Photonics in Next Generation Military Antenna Systems", S. Pappert, Department of the Navy, SPAWAR Systems Center, San Diego (SSC-SD), DARPA AOSP Study Group, December 6, 2000. <http://www.darpa.mil/mto/aosp/workshop/pappert.pdf>
2. "Photonic Signal Processing of High-Speed Signals Using Fiber Gratings", R. A. Minasian, Optical Fiber Technology, vol. 6, p.91-108 (2000).
3. "A 32-Element 8-bit Photonic True-Time-Delay System Based on a 288 x 288 3-D MEMS Optical Switch", IEEE Photonics Technology Letters, vol. 15, p.849-851 (2003).
4. "Compact, low insertion loss 16x16 optical switch-array modules", S. Thaniyavarn, J. Lin, W. Dougherty, T. Traynor, K. Chiu, G. Abbas, M. Lagasse, W. Charczenko and M. Hamilton, 1997 Optical Fiber Communication Conference (OFC-97) Technical Digest, vol. X, p.5-6 (1997).
5. "Fast Digitally Variable Differential Group Delay Module using Polarization Switching", L. S. Yan, C. Yeh, G. Yang, L. Lin, Z. Chen, Y. Q. Shi and X. Steve Yao, 2002 Optical Fiber Communication Conference (OFC-02) Technical Digest, Post Deadline Paper FA5-1 (2002).

KEYWORDS: Analog Photonics, Time Delay Modules, True-Time-Delay, TTD, Fiber Delay Lines, Wideband Beamforming, RF Photonics All-Optical Networks, Optical Buffering.

TPOC: Dr. Steve Pappert
Phone: (571) 218-4679
Fax: (703) 696-2206
Email: spappert@darpa.mil

SB042-034

TITLE: Large Area Portable Radar Antenna Arrays

TECHNOLOGY AREAS: Materials/Processes, Electronics, Battlespace

OBJECTIVE: Identify and develop innovative technology to enable large area portable radar antenna arrays.

DESCRIPTION: The performance of radar antenna arrays (angular resolution, sensitivity) improves dramatically with an increase in their size. Accurate angular resolution requires arrays meters on a side. In addition, portable systems need to be built on a flexible substrate that can be folded up for transport. Of the two methods to construct these arrays, placement of discrete devices onto a substrate that contains interconnect lines and direct manufacture of the devices on the substrate, the former method is inherently expensive due to the difficulty of accurately placing and binding the devices to their desired locations¹. The manufacture of polysilicon devices on flexible substrates has been demonstrated. These devices can be manufactured using a number of printing technologies that avoid high cost of lithography. Although, some simple devices have been made, the devices and processes must be improved to allow for devices which can handle the GHz frequencies of radar systems. In addition, methods must be developed to manufacture more complex circuits to provide integrated control of radar functions².

PHASE I: Conduct a feasibility study on improved performance printable electronic components. Identify materials and printing techniques that have the potential to produce large area portable radar antenna arrays.

PHASE II: Develop the materials and methods identified in Phase I and demonstrate a proof-of-concept array element.

PHASE III Dual Use Applications: The technology developed under this SBIR can be used in military and civilian commercial sensor arrays such as large area x-ray detectors for medical imaging.

REFERENCES:

1. J. Huang, M. Lou, A. Ferial, and Y. Kim, "An inflatable L-band microstrip SAR array," IEEE Antennas and Propagation

Society International Symposium, Atlanta, Georgia, pp. 2100-2103, June 1998."

2. Street, R.A., Mulato, M., Lau, R., Ho, J., Graham, J., Popovic, Z., Hor, J., Image capture array with an organic light sensor, Appl. Phys. Lett. 78, 2001, 4193-4195.

KEYWORDS: Sensor Array, Flexible Substrate.

TPOC: Dr. Robert Reuss
Phone: (703) 696-2214
Fax: (703) 696-2206
Email: rreuss@darpa.mil

SB042-035 TITLE: Physical Integrity Monitoring

TECHNOLOGY AREAS: Materials/Processes, Electronics, Battlespace

OBJECTIVE: Identify and develop innovative technology for continual monitoring of structural integrity of aerospace structures.

DESCRIPTION: Sensors and actuators distributed along the surface of aerospace structures (wings, fuselage, and storage tanks) can monitor the development of structural flaws such as cracks, corrosion, voids, delamination and joint integrity, or modify the structure for enhanced performance. Due to the centralized processing of the signals from the sensors, the monitoring system can have hundreds of wire connections and weigh hundreds of pounds. This has limited their use to specialized flight test aircraft. In order to reduce the space and weight requirements, local processing of the sensor data or control of the actuators needs to be accomplished. This processing includes amplification, signal conditioning, routing and switching, and analog to digital converter (ADC). In addition, the integration of both sensors and actuators, with the thin film transistors (TFTs) operating at the same high voltages of the Micro Electro-Mechanical Systems (MEMS) actuators, would benefit the space and weight requirements.

Where active methods are not possible, portable monitors for the non-destructive testing and inspection of large multishape structures are needed. First generation diagnostic systems, such as digital x-ray based on large area TFT arrays, are currently available. These need to be extended to 1) flexible substrates to better conform to the tested structure; 2) embedded control using distributed electronics and 3) the implementation of cost-effective solutions with TFT-based electronics integrated with sensors and actuators.

PHASE I: Conduct a feasibility study on improved performance printable electronic components. Identify materials and printing techniques that have the potential to produce active damage interrogation systems.

PHASE II: Develop the materials and methods identified in Phase I and demonstrate a proof-of-concept system.

PHASE III Dual Use Applications: The technology developed under this SBIR can be used in the monitoring of damage in military and civilian commercial aircraft and other equipment.

REFERENCES:

1. Kane, M. G., Campi, J., Hammond, M. S., Cuomo, F. P., Greening, B., Sheraw, C. D., Nichols, J. A., Gundlach, D. J., Huang, J. R., Kuo, C. C., Jia, L., Klauk, H., Jackson T. N., Analog and Digital Circuits Using Organic Thin-Film Transistors on Polyester Substrates, IEEE Elec. Dev. Lett., 21, 2000, 534-536.

KEYWORDS: Sensor Array, Flexible Substrate.

TPOC: Dr. Robert Reuss
Phone: (703) 696-2214
Fax: (703) 696-2206
Email: rreuss@darpa.mil

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